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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/520,964	03/08/2000	Michele M. Covell	013155063	1643

21839 7590 02/25/2004

BURNS DOANE SWECKER & MATHIS L L P
POST OFFICE BOX 1404
ALEXANDRIA, VA 22313-1404

EXAMINER	
AKHAVANNIK, HUSSEIN	
ART UNIT	**PAPER NUMBER**
2621	13

DATE MAILED: 02/25/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/520,964	COVELL ET AL.	
	Examiner	Art Unit	
	Hussein Akhavannik	2621	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-6,10-23 and 28-30* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-6,10-23 and 28-30* is/are rejected.

7)☒ Claim(s) *28-30* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *28 November 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *11*.
4) ☒ Interview Summary (PTO-413) Paper No(s)/Mail Date. *8* .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Drawings

1. The drawings were received on November 28, 2003. These drawings are accepted.

Information Disclosure Statement

2. The information disclosure statement (IDS) submitted on November 28, 2003 was filed after the mailing date of the non-final rejection on July 22, 2003. The submission is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Response to Arguments

3. Applicant's arguments with respect to claims 1, 11, and 21 have been considered but are moot in view of the new ground(s) of rejection.

Claim Objections

4. Claims 28-30 are objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. The limitations of shifting the focus of expansion by an integer value, shifting the focus of expansion to improve the accuracy of a constraint, and shifting the focus of expansion non-iteratively to improve the accuracy of a constraint as recited by claims 28, 29, and 30, respectively, are all recited by independent claim 1.

Claim Rejections - 35 USC § 112

5. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it

> pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

6. Claims 1-6, 7-23, and 28-30 are rejected under 35 U.S.C. 112, first paragraph, because the specification, while being enabling for "allowing the focus of expansions (FOE) of each point to shift "independently" by some integer amount, (S_x, S_y)" on page 25, lines 5-8 of the specification, does not reasonably provide enablement for "shifting a focus of expansion of the points on the figure by an integer value to non-iteratively improve an accuracy of a constraint" in claim 1, lines 5-6 and corresponding portions of claims 11 and 21. The specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make the invention commensurate in scope with these claims.

The recitation of "shifting of the focus of expansion of the points on the figure by an integer value to non-iteratively improve an accuracy of a constraint" in independent claims 1, 11, and 21 does not require that the shift be independent of the previous shift. There may be a non-iterative shift (which the examiner construes to be not limited by the area of an original focus of expansion), which is dependent of the previous shift. For example, by shifting a focus of expansion by a predetermined integer pixel distance, the shift is dependent on the location of the previous focus of expansion, but is also non-iterative because the shift is not constrained by the area of the first focus of expansion. However, the specification requires an independent shift in this embodiment.

Claims 2-6, 10, 12-20, 22-23, and 28-30 are rejected as being non-enabled for depending from a non-enabled antecedent base claim.

7. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

8. Claims 1-6, 7-23, and 28-30 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Referring to claim 1, 11, and 21, the step of "shifting a focus of expansion of the points on the figure by an integer value to non-iteratively improve an accuracy of a constraint" is indefinite. On page 24, line 12 to page 25, line 4 of the specification, the Applicant explains that the iterative estimation approach of first-order Taylor-series expansion used in brightness and depth constraints has several drawbacks. Then, on page 25, lines 5-16 of the specification, the Applicant introduces a method to improve the accuracy of the constraints "without iteration" by allowing the focus of expansions of each point to shift "independent" by some integer amount. Finally, on page 26, lines 1-9 of the specification, the Applicant explains that selecting the integer amounts (S_x, S_y) could be done within the traditional iterative motion estimation framework. The Applicant explains that the motion is re-estimated according to the constraint equations, resulting in hierarchical and iterative processing. Therefore, it is not understood whether the determination of the integer values is non-iterative (as claimed) or iterative (as explained on page 26, lines 1-9) in light of the specification.

Claims 2-6, 10, 12-20, 22-23, and 28-30 are rejected as being indefinite for depending from an indefinite antecedent base claim.

Note: The uncertainties in this claim rises to the level of a 35 U.S.C. 112 rejection because of the inconsistency between the claimed subject matter and the specification (See MPEP 2173.03).

Claim Rejections - 35 USC § 103

9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

10. Claims 1-3, 6, 11, 16, and 28-30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sabata et al (B. Sabata and J. Aggarwal. Estimation of motion from a pair of range images: A review. CVGIP, 54(3): 309–324, Nov. 1991.) in view of Nakajima et al (U.S. Patent No. 5,521,633).

Referring to claim 1,

i. Obtaining dense range data that describes the distance of points on the figure from a reference is explained by Sabata et al on page 310, second column, third paragraph. Sabata et al explain that the range image is the 3D coordinate of each point (or pixel) sensed. A 3D coordinate inherently includes both the horizontal and vertical coordinates of the object in space and also the distance of the object from the image sensor.

ii. Shifting a focus of expansion of the points on the figure by an integer value to non-iteratively improve an accuracy of a constraint is not explicitly explained by Sabata et al. However, Nakajima et al illustrate in figure 10(a) and 10(b) that a focus of expansion is shifted by an integer value on a figure in order to non-iteratively improve an accuracy of a constraint. The Examiner construes a focus of expansion to be a point and it corresponding search window on an original figure for which the position (or pose) in a next figure is being determined. In figure 10(a) of Nakajima et al, the focus of expansion

is point P and its corresponding window is W_1. The Examiner construes a non-iterative shift to be a shift that is not limited by the area of the window of the original focus of expansion. In figure 10(b), Nakajima et al clearly illustrate that the focus of expansion (P) is shifted in a raster fashion of a second figure, which is non-iterative. Nakajima et al explain that for each shift, a correlation value is determined in column 1, lines 26-42. The correlation equation of Nakajima et al is a function of the coordinates of the pixels of the first focus of expansion and the shifted focus of expansion, as therefore, corresponds to an integer shift within each figure. Once the original focus of expansion has been shifted across the entire second figure, the focus of expansion with the highest correlation value is determined to be the next pose of an object. In figure 10(b), the second focus of expansion corresponds to point Q and its window W_2. Nakajima et al also explain using range data in order to improve the detection of an object in column 1, lines 43-48. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to shift the focus of expansion of the points on a figure by an integer value using the system of Nakajima et al to non-iteratively improve the accuracy of the constraint in the system of Sabata et al because determining the motion of a point from all the points on a subsequent frame would improve the accuracy of motion detection and pose estimation.

iii. Processing the dense range data to estimate the pose of the figure is explained by Sabata et al on page 310, second column, third paragraph. Sabata et al explain that the motion of a rigid object in an image is estimated, corresponding to the pose of the object ("pose determination" on page 309, first column, second paragraph).

Referring to claim 2, the dense range data being processed in accordance with a set of depth constraints to estimate the pose is explained by Sabata et al on page 312, first column, first and second paragraphs. Sabata et al explain on page 311, first column, forth paragraph that the pose estimation is determined by both a rotational component (R) and a translational component (T). Sabata et al then provide constraints to simplify the calculation of the rotation matrix to estimate the rotational component of the pose estimation.

Referring to claim 3, the depth constraints being linear is explained by Sabata et al on page 311, first column, forth paragraph. Sabata et al explain that the rotational component of the pose estimation, which is constrained corresponding to claim 2, is a linear transform.

Referring to claim 6, the dense range data being compared with an estimate of pose to produce an error value and iteratively revising the estimate to minimize the error is explained by Sabata et al on page 311, first column, second and third paragraph. Sabata et al explain determining the error (E_{est}) of the motion estimations and minimizing the error.

Referring to claim 11,

i. Obtaining dense range data that describes the distance of points on the figure from a reference corresponds to claim 1i.

ii. Shifting a focus of expansion of the points on the figure by an integer value to non-iteratively improve an accuracy of a constraint corresponds to claim 1ii.

iii. Processing the dense range data in accordance with a set of linear depth constraints to estimate the pose of the figure corresponds to claim 2.

Referring to claim 16,

i. The estimate of the pose of the object including an estimate for each of the orientation and translational positions of the object is explained by Sabata et al on page 310, first column, forth paragraph. Sabata et al explain estimating the rotational component, corresponding to the orientation, and the translational component of the motion of an object.

ii. Decoupling the estimate of orientation from the estimate of the translational position is explained by Sabata et al on page 311, second column, first paragraph. Sabata et al clearly illustrate that the position of point on a succeeding frame is represented by the rotational component and the translational component independently.

Referring to claim 28, the focus of expansion being shifted by an integer value corresponds to claim 1i.

Referring to claim 29, shifting the focus of expansion improving an accuracy of a constraint corresponds to claim 1i.

Referring to claim 30, shifting the focus of expansion non-iteratively improving an accuracy of a constraint corresponds to claim 1i.

11. Claims 4-5, 10, 12-15, 17, and 21-23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sabata et al in view of Nakajima et al, and further in view of Bregler et al (Bregler, C.; Malik, J. Tracking people with twists and exponential maps. 1998 IEEE Computer Society Conference on Computer Vision and Pattern Recognition, 23-25 June 1998. Page(s): 8 - 15.).

Referring to claims 4, 10, and 15, obtaining brightness data in accordance with a set of linear brightness constraints to estimate the pose is not explicitly explained by Sabata et al or

Nakajima et al. Sabata et al do explain that the intensity (corresponding to the brightness) of an image is widely used in the art to determine the motion of an object on page 309, first column, second paragraph to page 309, second column, first paragraph. However, Sabata et al do not explain linear brightness constraints on the intensity data. Bregler et al do explain linear constraints on the brightness data on page 9, first column, forth through seventh paragraphs. Bregler et al explain constructing an over-constrained set of equations for the motion model, assuming that the motion is linear. By applying the linearly constrained brightness data into the motion data determined by the range data of Sabata et al and Nakajima et al, the motion of an object through a series of frames will be estimated more accurately. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use brightness data in accordance with a set of linear brightness constraints to better determine the pose of an object.

Referring to claim 12, the object being articulated is not explicitly explained by Sabata et al or Nakajima et al. However, Bregler et al do illustrate estimating the pose of an articulated object in figure 2. The system of Sabata et al and Nakajima et al models the motion of an object by the rotational and translation components of the object's movement. Thus, an articulated object could be efficiently tracked in the system of Sabata et al and Nakajima et al. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to track an articulated object using the system of Sabata et al.

Referring to claims 5 and 13, the depth constraints being represented by twist mathematics is not explicitly explained by Sabata et al or Nakajima et al. However, Bregler et al do explain using twist mathematics in order to estimate the pose of a figure on page 8, second

column, first paragraph. Bregler et al explain that using twist mathematics in motion estimation, such as the estimation of Sabata et al and Nakajima et al, greatly simplifies the estimation and leads to a more robust tracking result on page 8, second column, second paragraph. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use twist mathematics as suggested by Bregler et al in the motion estimation system of Sabata et al and Nakajima et al in order to perform the motion estimation and object tracking more robustly.

Referring claim 14,

i. Mapping the parameters that describe the rotation and translation of the object to a set of linear parameters is explained by Sabata et al on page 311, second column, second paragraph. Sabata et al explain that the rotation and translation components of the object movement are characterized by individual matrices.

ii. Solving for the depth constraints is explained by Sabata et al on page 312, first column, first and second paragraph. The rotational depth constraints are explained by Sabata et al and used to estimate the object motion.

iii. Re-mapping back to the original parameters to provide a pose estimate is explained by Sabata et al on page 313, second column, fifth paragraph to page 314, first column, first paragraph. Sabata et al explain that the parameters which determine the rotational and translational components of the object are used in order to solve for the motion of the object.

Referring to claim 17, the reference comprising a location on the object and the pose being estimated from the positions of points on the object relative to the locations is explained by

Sabata et al on page 310, second column, sixth paragraph to page 311, first column, second paragraph. Sabata et al explain determining the current position of an object (P') from the previous position of the object (P) after the determined transformation of the object.

Referring to claim 21,

i. Obtaining dense brightness data for pixels in each of the video images is explained by Sabata et al on page 309, first column, second paragraph.

ii. Obtaining dense range data for pixels in each of the video images corresponds to claim 1i.

iii. Determining an initial pose for the object in one of the video images is explained by Sabata et al on page 311, first column, forth paragraph by p, which is the initial point on an object undergoing a transformation.

iv. Estimating changes in at least one of the translational position and rotational orientation of the object for successive images on the basis of the brightness data and range data, shifting a focus of expansion of the points on the figure by an integer value to non-iteratively improve an accuracy of a constraint to estimate the pose of the object in successive images corresponds to claims 1ii, 1iii, and 4, wherein the pose is determined using the range data and the brightness data.

Referring to claim 22, the object being articulated corresponds to claim 12.

Referring to claim 23, the estimates being obtained by means of linear constraint equations that are applied to the brightness data and the range data corresponds to claims 4 and 3, respectively.

12. Claims 18-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sabata et al in view of Nakajima et al, and further in view of Dubuisson-Jolly et al (U.S. Patent No. 6,195,445).

Referring to claim 18, the pose of an object being estimated for each image in a sequence of images and selecting a rigid translation value for each point on the object from one image to the next is not explicitly explained by Sabata et al or Nakajima et al. However, Dubuisson-Jolly et al do illustrate rigid translation values for an articulated object in figure 4 by segment lengths Φ_1 to Φ_7 and explain polyline contours in column 6, lines 49-65. Dubuisson-Jolly et al explain that the polyline contours are tracked in an image sequence using an initial polyline contour in an input frame in column 6, lines 66 to column 7, line 10. By using the rigid translation value method of Dubuisson-Jolly et al, the processing required to track the motion of an articulated object would be reduced in the system of Sabata et al and Nakajima et al. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a rigid translation value for each segment of an articulated object in order to track the motion of an object more efficiently.

Referring to claim 19, the rigid translation value being an integer value corresponds to claim 18, wherein Φ_1 to Φ_7 may represent integer values of the rigid translation.

Referring to claim 20, the rigid translation values being different for different points on the object corresponds to clam 18, wherein each segment, D, has a specific and different rigid translation value Φ.

Conclusion

13. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

14. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hussein Akhavannik whose telephone number is (703)306-4049. The examiner can normally be reached on M-F 8:30-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Leo H. Boudreau can be reached on (703)305-4706. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Hussein Akhavannik
February 18, 2004

LEO BOUDREAU
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2600